MODELING THE INFLUENCE OF NEAR-SURFACE TEMPERATURE GRADIENTS ON THERMAL EMISSION FROM AIRLESS BODIES.

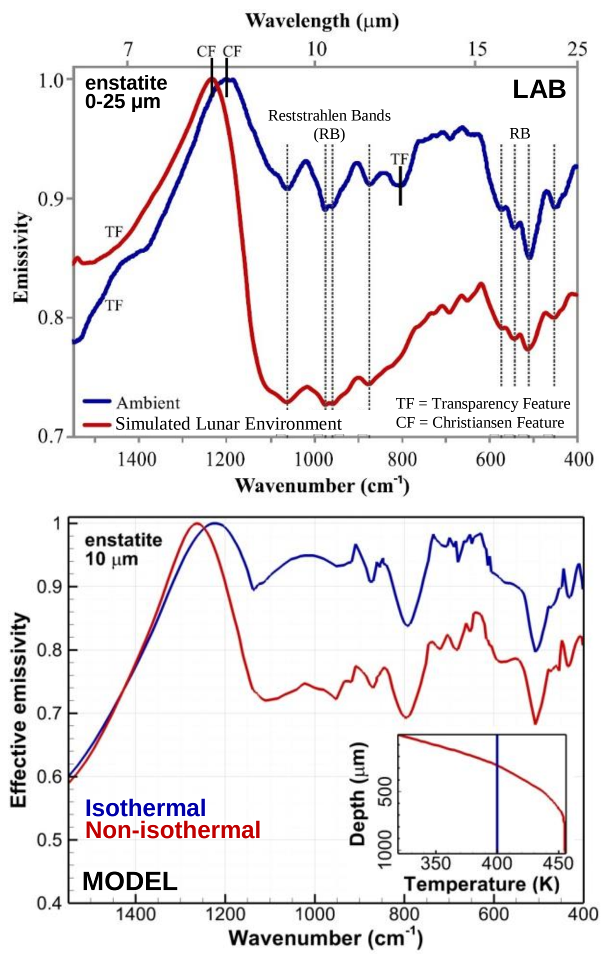
P. Prem[1*], B. T. Greenhagen[1], J. A. Arnold[2], K. L. Donaldson Hanna[3] and N. E. Bowles[3]; [1]Johns Hopkins University Applied Physics Laboratory, [2]Department of Terrestrial Magnetism, Carnegie Institution of Washington, [3]University of Oxford; [*]parvathy.prem@jhuapl.edu.

Background & Motivation: Measurements of thermal emission from airless bodies provide a powerful means of determining surface composition and thermophysical properties. However, the interpretation of thermal infrared spectra from airless bodies is often complicated by the presence of distinctive thermal environments. In particular, the low thermal conductivity of a fine-particulate, evacuated regolith can give rise to dramatic near-surface temperature gradients. For instance, on the Moon, temperatures may vary by as much as ~40-60 K over the uppermost 100 μm of the regolith [1]. Measured "surface" thermal emission originates within this thin, non-isothermal layer – the 'epiregolith' [2] – such that the range of temperatures within the epiregolith is reflected in measured emission spectra (see *Figure 1*). Quantifying the influence of near-surface temperature gradients on thermal emission spectra is, therefore, key to interpreting lab and remote-sensing data. In this work, we explore this relationship further, focusing in particular on the retrieval of the near-surface temperature profile from a measured emission spectrum.

Method: We model thermal emission from a nominal epiregolith using a Monte Carlo radiative transfer approach. The sub-surface temperature profile is approximated by a series of isothermal layers; thermal emission from each layer is modeled by tracking the propagation of representative "energy packets" through the medium. Wavelength-dependent scattering and absorption properties determine the contribution of each sub-surface layer to the measured emission spectrum. The Monte Carlo code requires as input scattering and absorption coefficients, and the scattering asymmetry parameter, currently obtained using a Mie scattering code [3]. We are also exploring the use of the more theoretically rigorous Multiple Sphere T-Matrix method [4] to obtain more accurate input parameters. This approach allows us to model emission spectra for a range of regolith compositions/grain sizes and temperature profiles. Integrating this forward model with an iterative inverse model allows us to retrieve a best-fit temperature profile for a given emission spectrum.

To validate the modeling approach, we compare model results to lab spectra acquired under ambient and simulated lunar conditions at the University of Oxford and JHU-APL.

Results: *Figure 1* (right) compares lab spectra from [5] to preliminary model results for representative temperature profiles. The model qualitatively captures the shift in the location of the Christiansen Feature, and the change in spectral contrast under simulated lunar conditions – caused by the presence of steep near-surface temperature gradients. Potential sources of discrepancies between the lab and model results include differences in the particle size, optical constants (from [6]) and temperature profiles used to obtain the model spectra, as well as inaccuracies in the calculation of scattering parameters. We will report on our progress towards addressing these discrepancies, and discuss the insights that this work provides into the near-surface thermal environment on the Moon and other airless bodies.



References: [1] Henderson & Jakosky, 1994, *JGR.* [2] Wendell & Noble, 2010, *LPSC.* [3] Maetzler, 2002, *Univ. Bern.* [4] Mackowski & Mishchenko, 2011, *JQSRT.* [5] Donaldson Hanna et al., 2012, *JGR.* [6] Roush et al., 1991, *Icarus*.